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Soot

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(54) **WINCH SYSTEM FOR RAISING AND LOWERING THEATRE SCENERY**

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(52) **U.S. Cl.** **254/331**; 160/331; 160/344

(58) **Field of Search** 254/329, 331, 254/338, 378, 388, 389; 160/331, 344, 143

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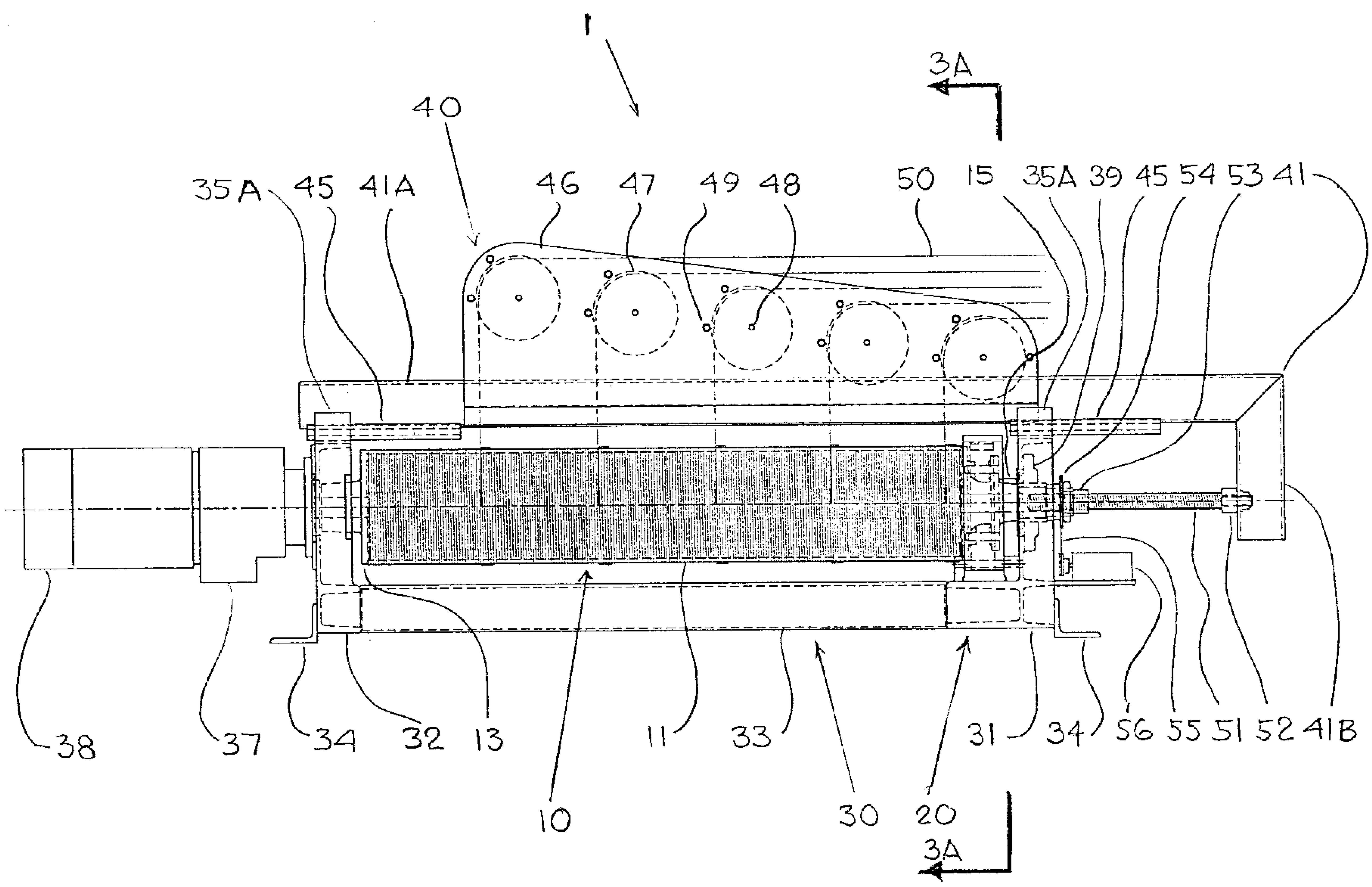
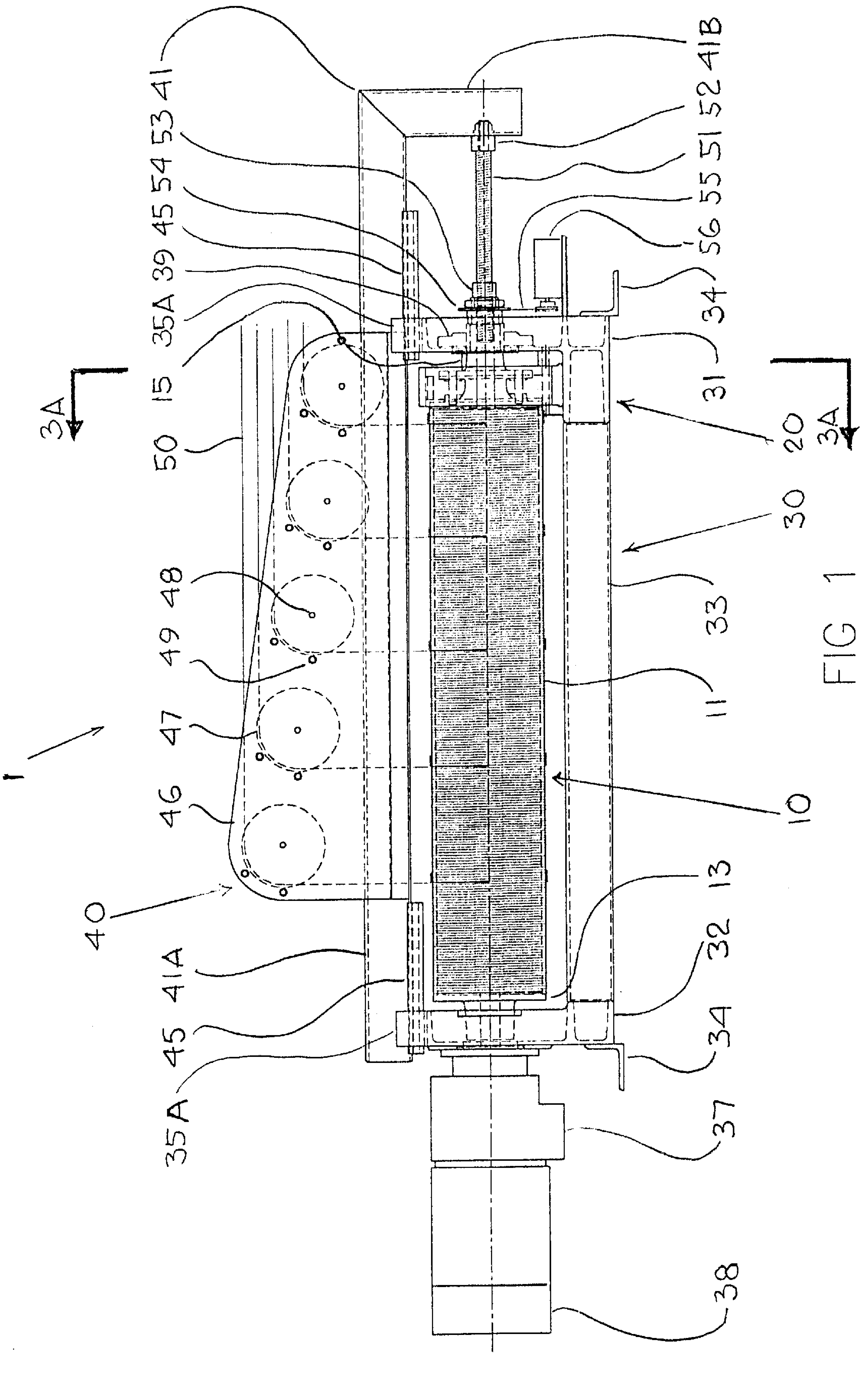
Primary Examiner—Emmanuel Marcelo

(57) **ABSTRACT**

A motorized fly system winch, drum and carriage combination for raising and lowering, for example, theatre scenery by means of cables and which incorporates functions for emergency braking, for moving the drum in synchronization with relation to the carriage containing cable-guiding means and for driving of a limit switch if desired. The winding and unwinding the cables on or off the drum does not change the cable runs relative to the theatre. The fly system winch can be installed at the sides of the stage, up at the stage gridiron, or above the gridiron. With this combination, counterweights are unnecesary. The fly system winch is compact and can be economically manufactured.

33 Claims, 14 Drawing Sheets

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38

FIG 1

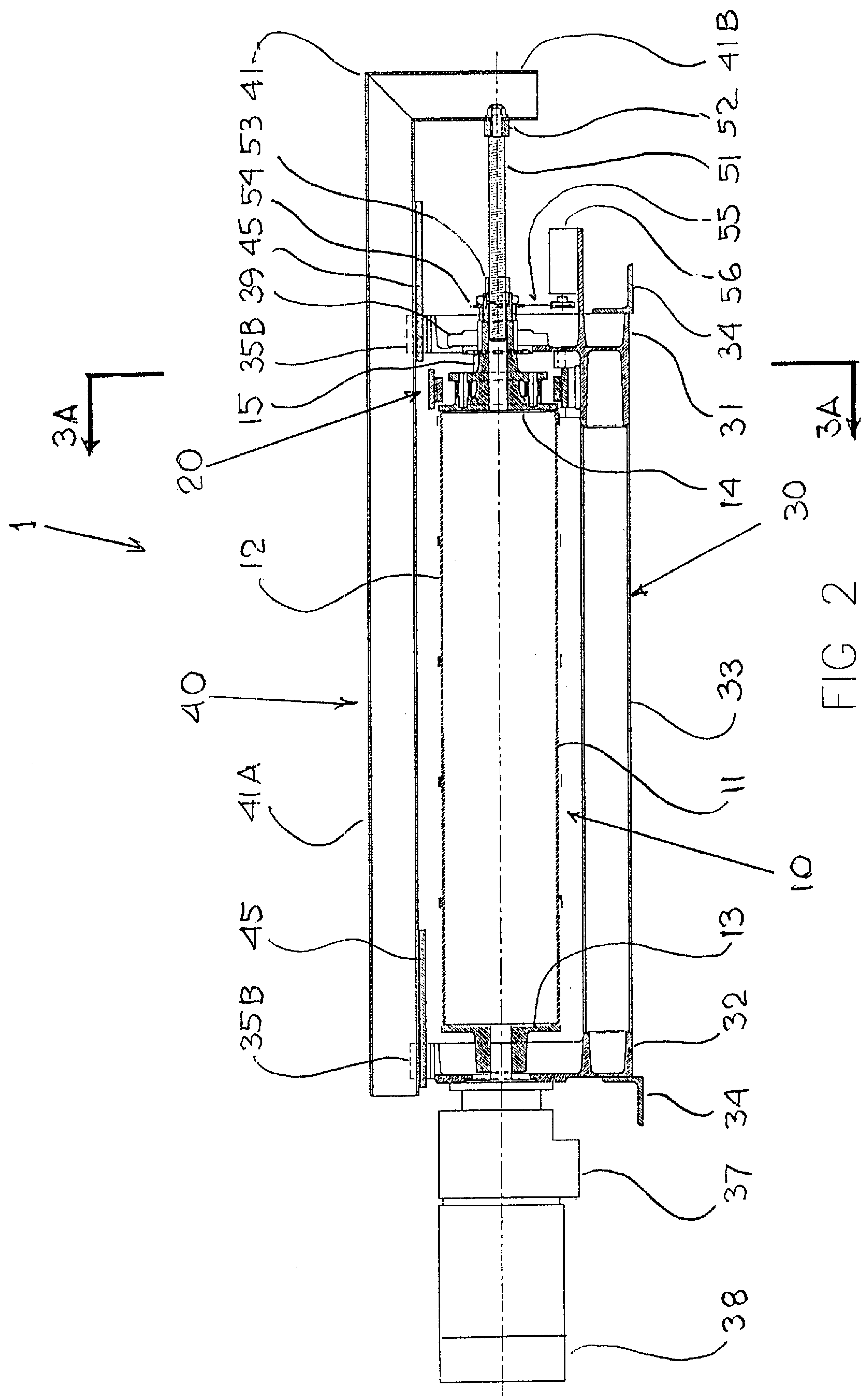
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FIG 2

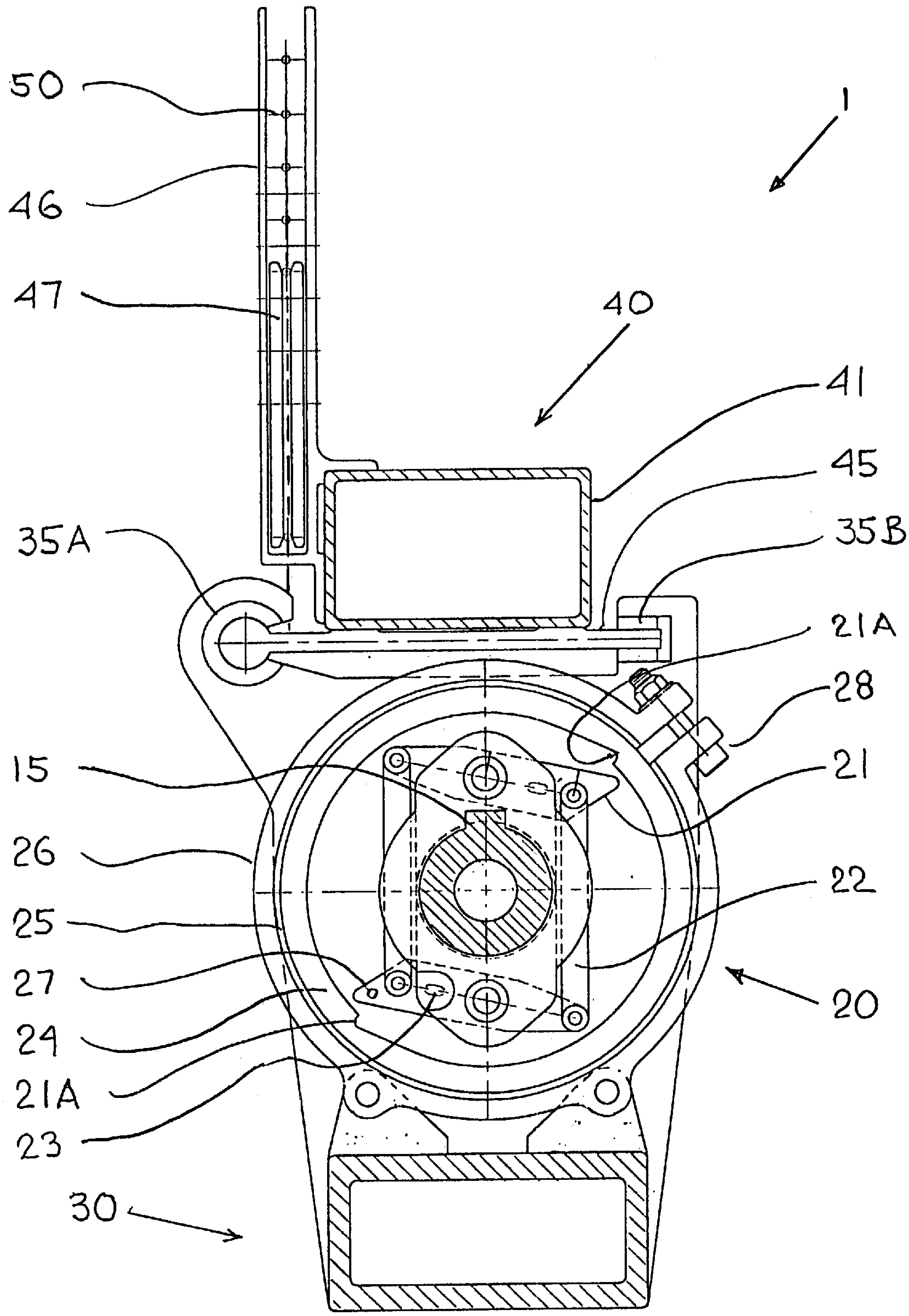
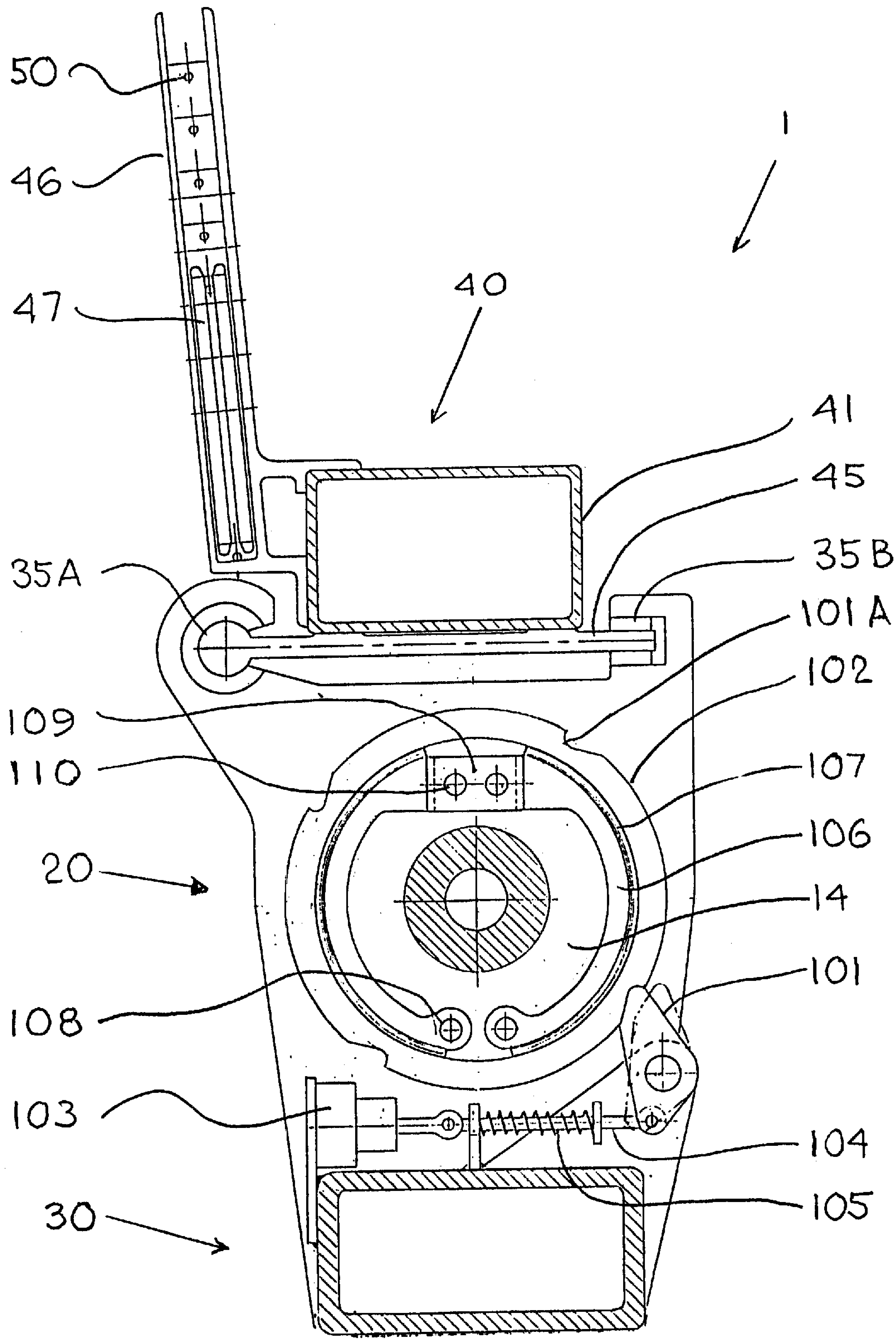


FIG 3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46
47
1
40
41
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104
105
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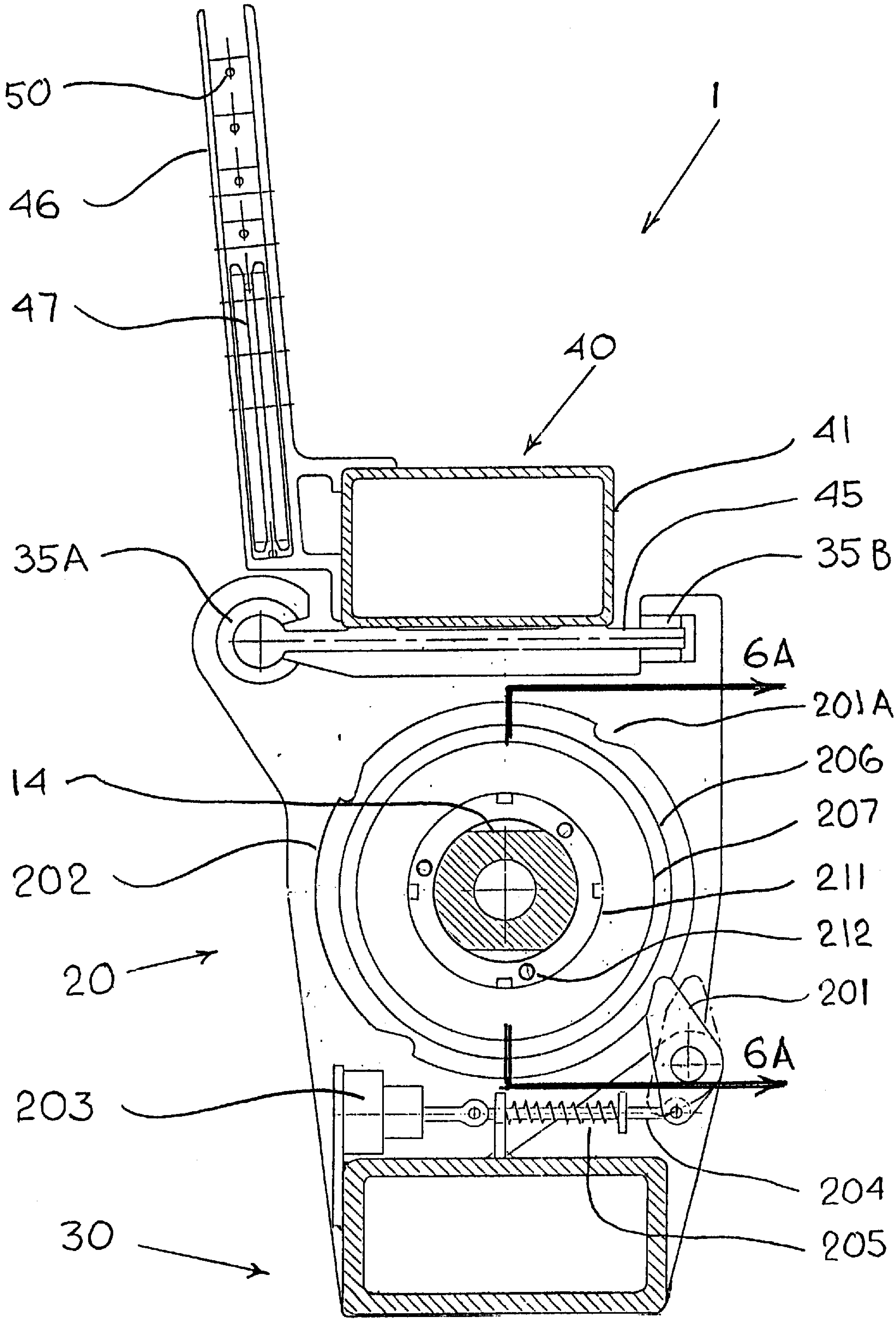
FIG. 4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201
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203
204
30
205

FIG 5

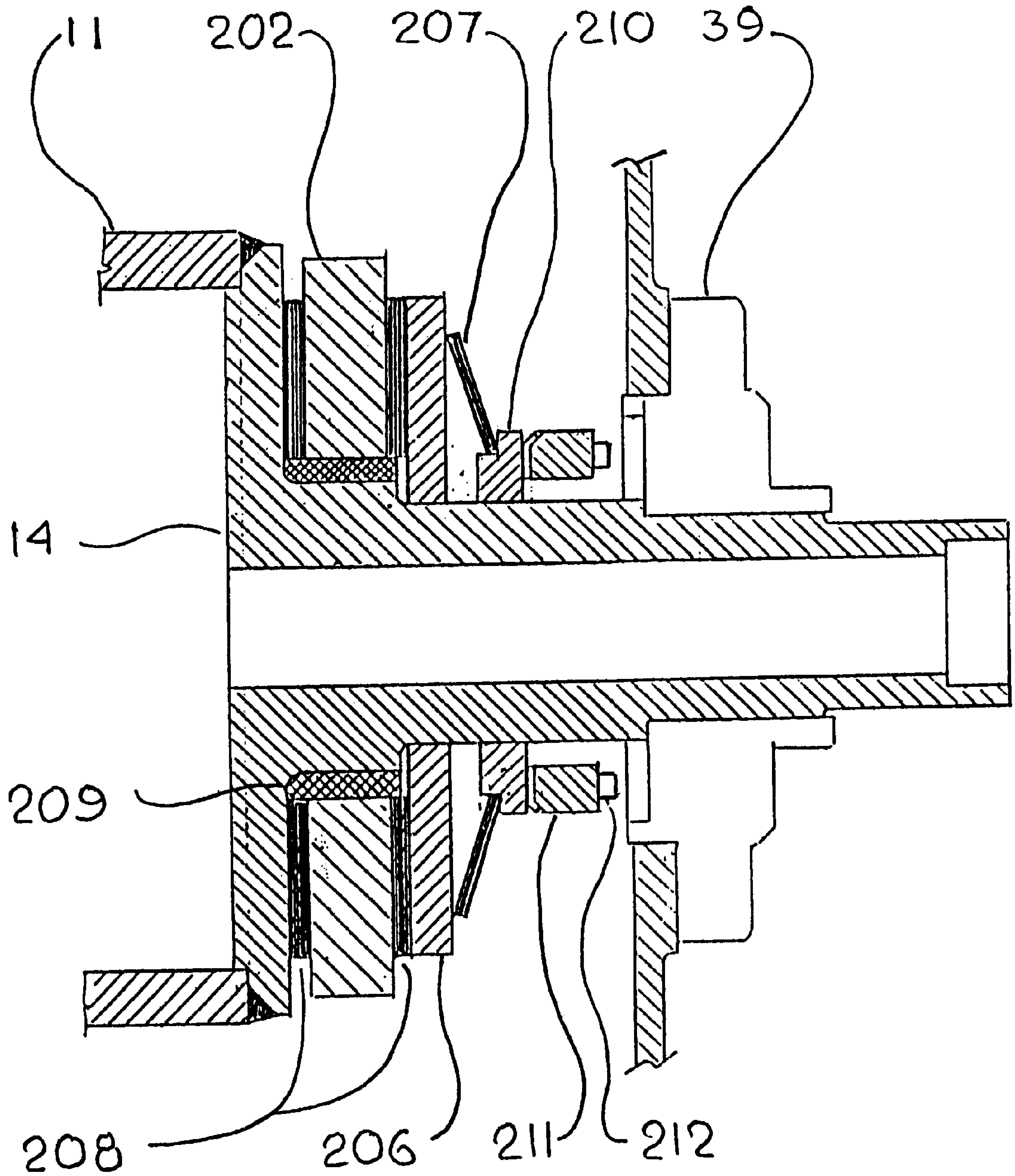
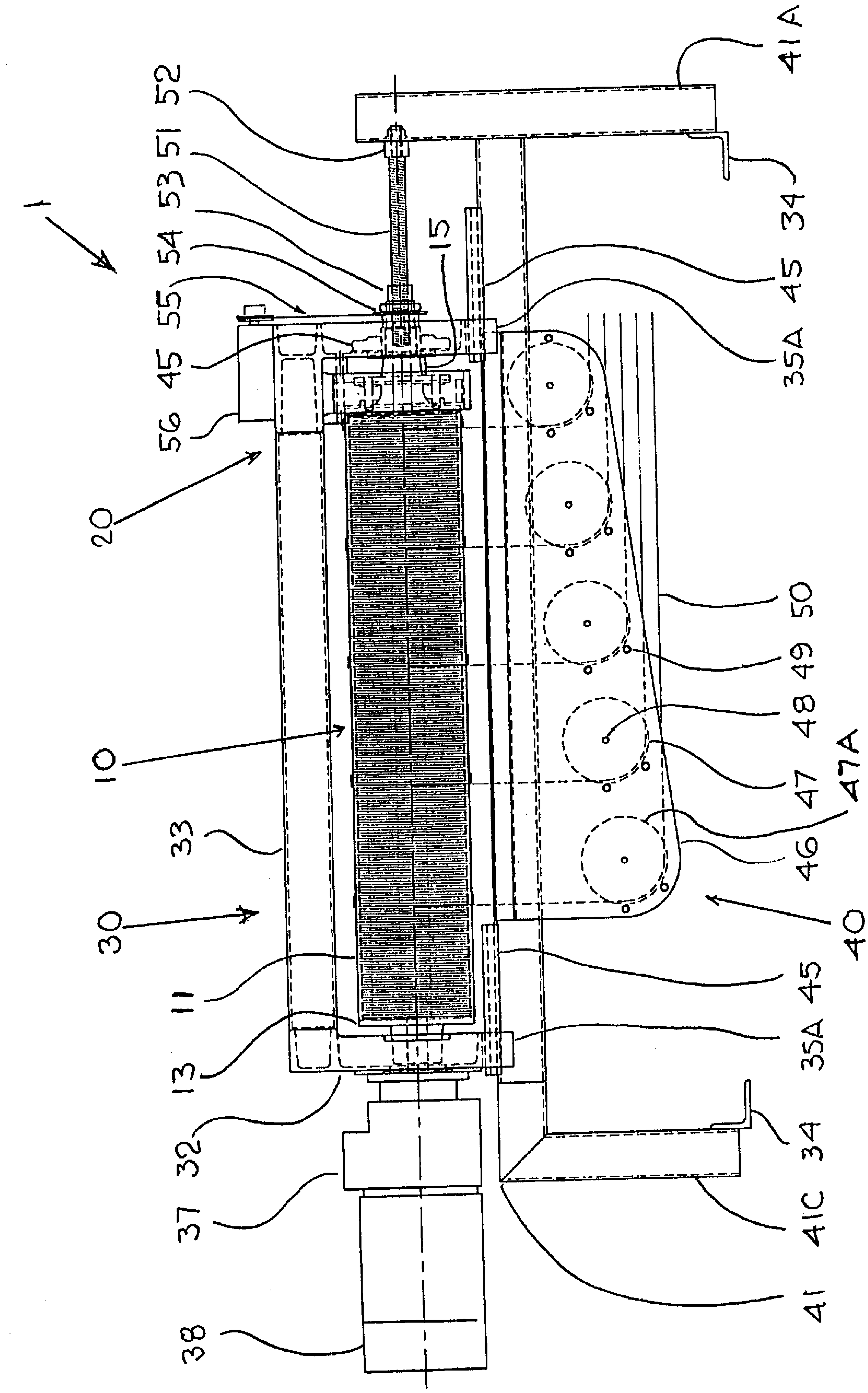


FIG 6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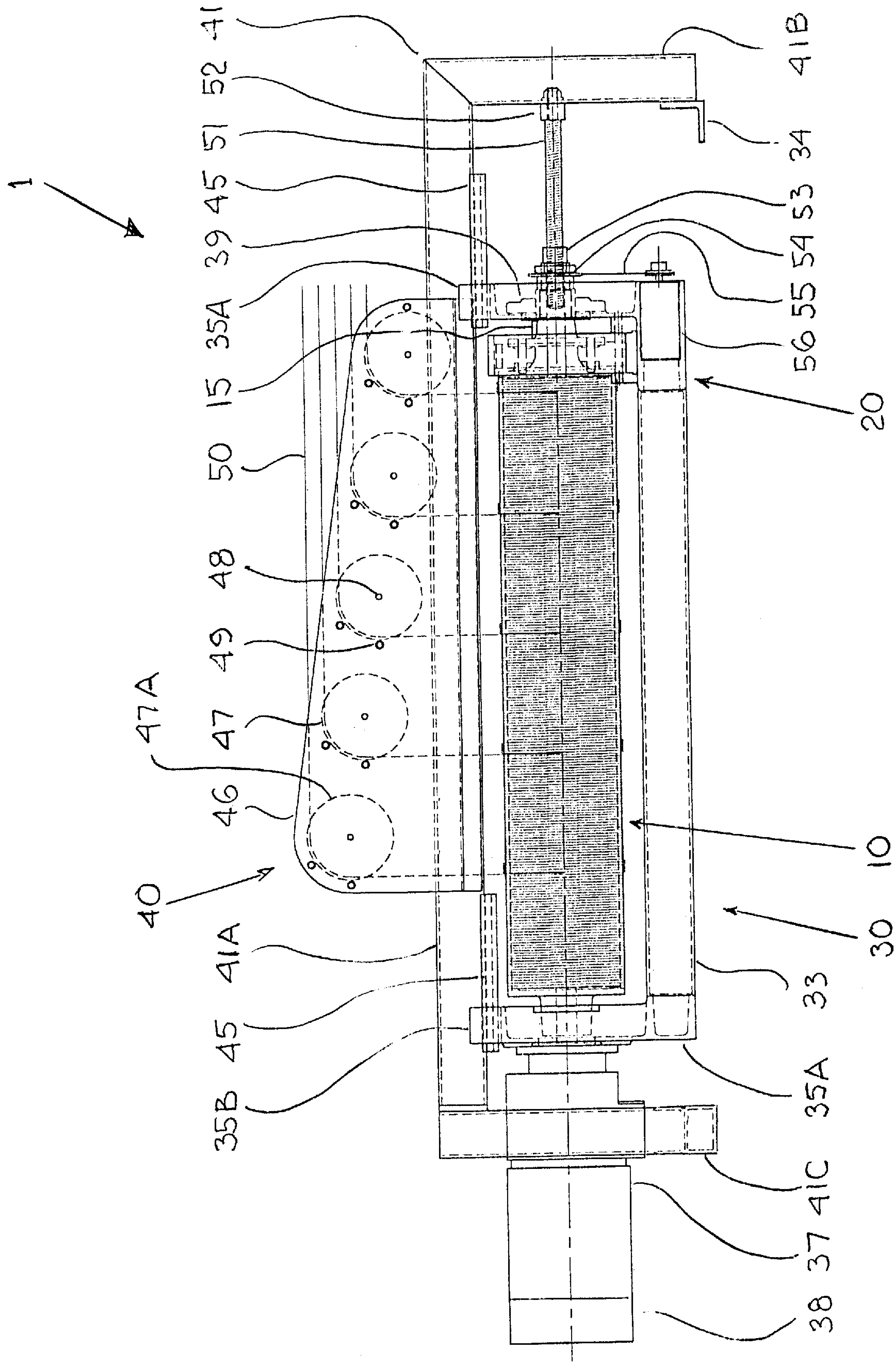
35A
34
41C
41

FIG 7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10
30
33
35A
41C
37
38

FIG 8

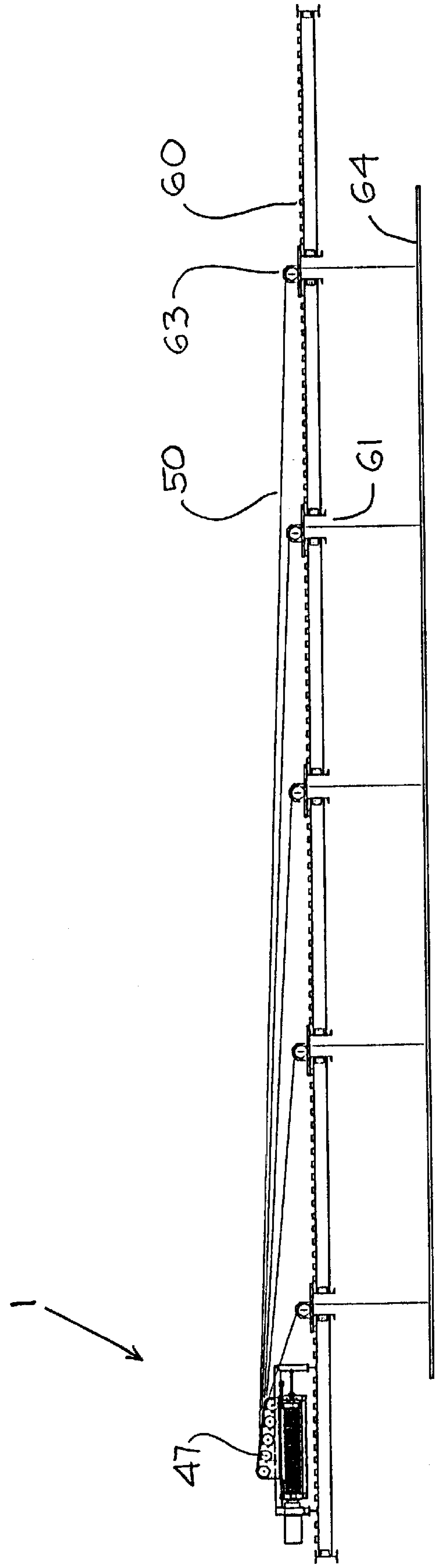

FIG 9

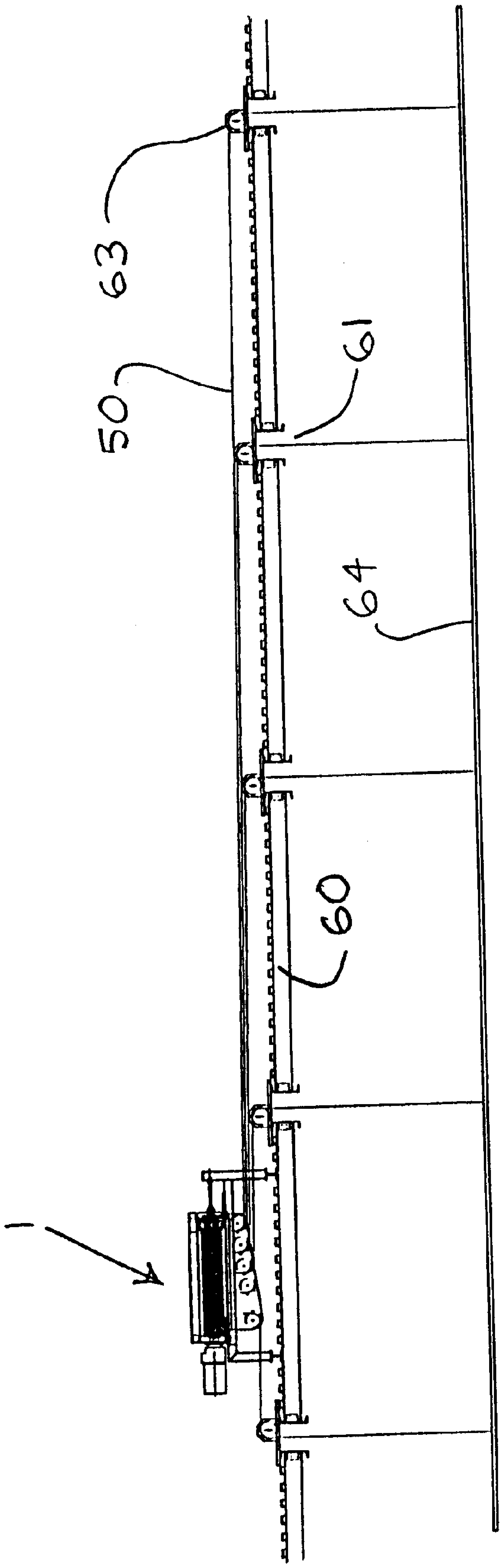

FIG 10

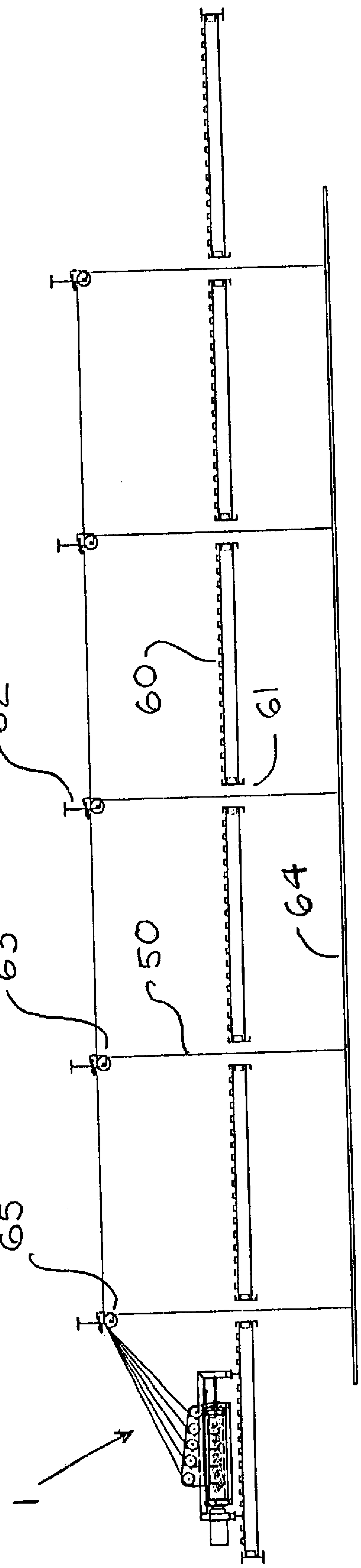

FIG 11

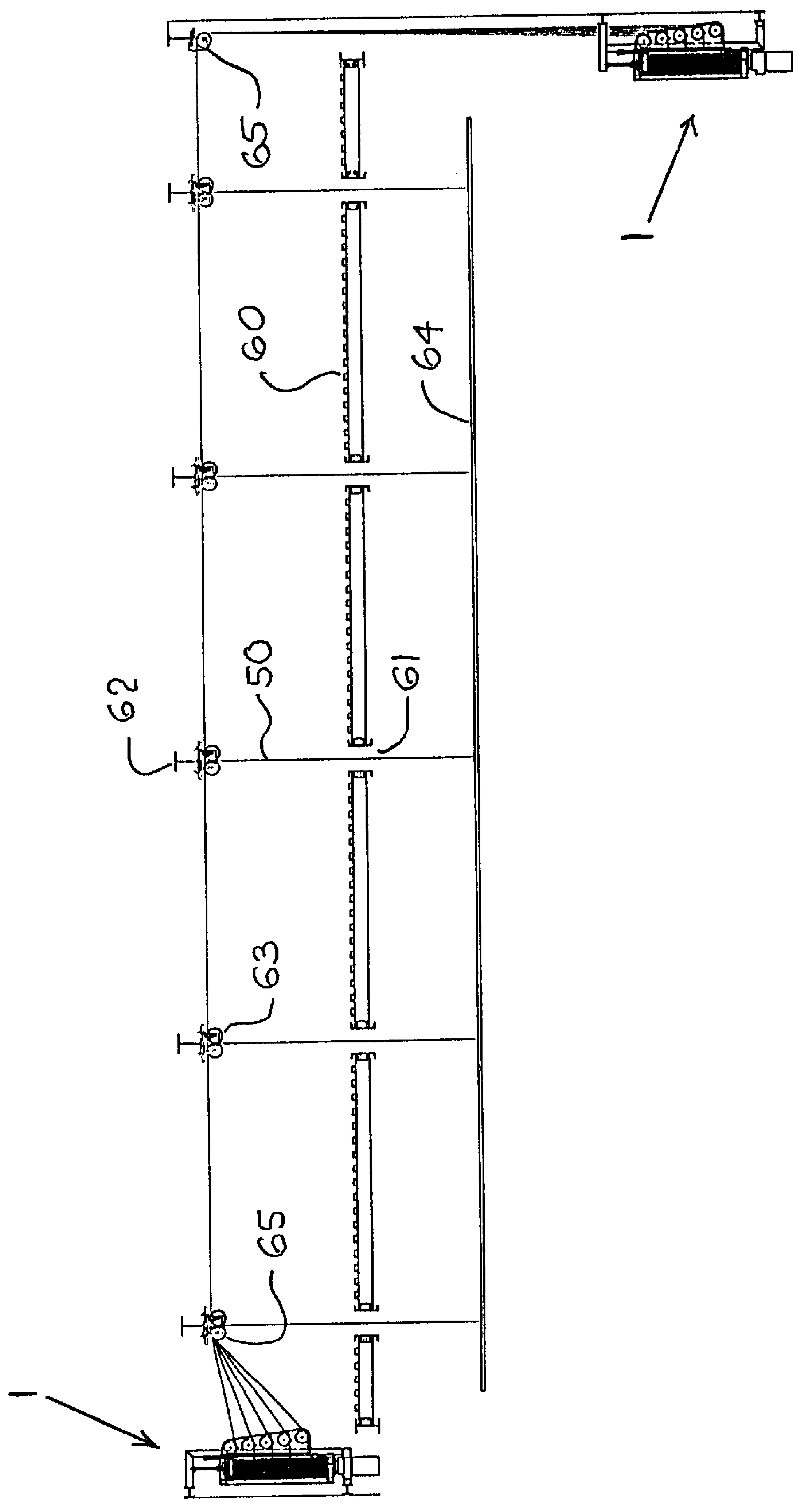

FIG 12

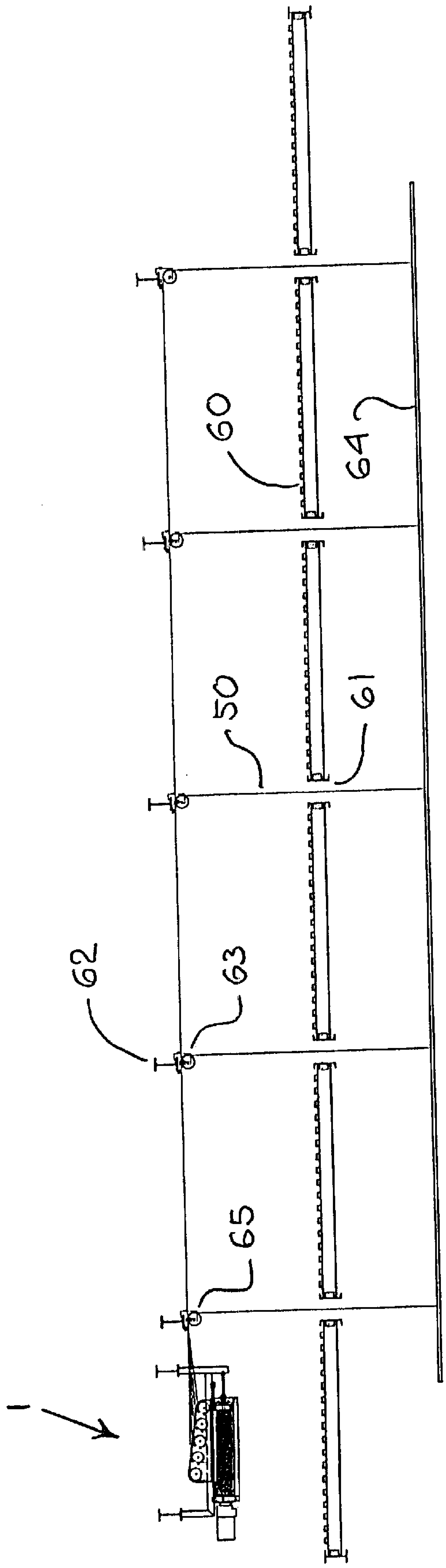

FIG 13

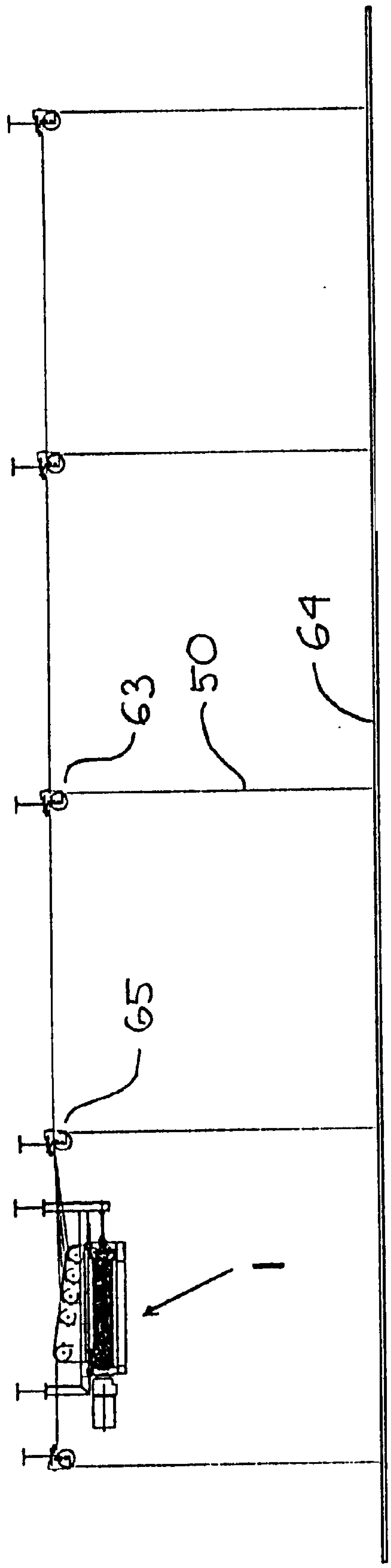

FIG 14

WINCH SYSTEM FOR RAISING AND LOWERING THEATRE SCENERY

This invention is based on Disclosure Document No 474944, filed May 30, 2000.

This invention is directed to raising and lowering objects, in particular, objects such as theater scenic elements, suspended from fly sets, by failsafe motorized means.

BACKGROUND OF INVENTION

Most of the present-day fly systems in theaters are manually operated counterweight sets. Each counterweight set consists essentially of one pipe batten, somewhat longer than the width of the proscenium opening, suspended by lines or cables, such as wire ropes, which are spaced approximately 8–10 ft apart along its length. Each wire rope passes from the suspended pipe batten over a sheave or loftblock, which is either mounted on the stage gridiron or underhung from the stagehouse roof beam. From the loftblocks all lines lead to a common headblock, mounted at one side of the stage and pass over it down to a counterweight arbor. The counterweight arbor is typically a steel frame, supporting lead, cast iron or steel weights. Counterweight arbors are guided by tee tracks, mounted on the stage side wall.

An operating rope is tied to the top of each counterweight arbor. From there it goes up and over the headblock, then down and around a rope tension sheave, (which is located below the counterweight usually at stage floor height) and up again where it is connected to the bottom of the counterweight arbor. The operating rope also passes through a friction type rope lock, which holds the nearly balanced pipe batten and counterweight arbor in position. The pipe battens are usually spaced six inches on center, parallel to the proscenium opening, and are sometimes spaced even closer. Wider spacing is used in smaller theaters. The number of fly sets in theaters varies. A small high school theater may have only 20–25, whereas more than 100 may be used in large theaters.

These known systems have disadvantages. Loading and unloading counterweights for balancing the loads suspended by the pipe battens is time consuming and dangerous. The loading and unloading of weights usually happens when the batten is at stage level and the counterweight arbor is at gridiron level. There have been numerous accidents when counterweights were dropped from 60–70 feet above the stage onto people standing below operating other counterweight sets. In case of unbalance, the pipe batten and counterweight may run away when the rope lock is opened.

While some motorized winches have been used in larger theaters, they are expensive and often not affordable for smaller theaters.

BRIEF SUMMARY OF INVENTION

An object of the present invention is a motorized failsafe fly system winch that can be substituted for the manually operated counterweight set Anther object of the present invention is a motorized failsafe fly system winch that is compact and can be economically manufactured.

A further object of the present invention is a motorized failsafe fly system winch which does not require counterweights and which permits elimination and simplification of several parts, normally used for similar winches, without sacrificing the functioning.

Yet another object of the invention is a movable winch drum and carriage combination for raising and lowering theatre scenery which incorporates functions for emergency braking, for moving the drum (and its support base) in synchronization with relation to the carriage and for driving of a limit switch if desired.

A still further object of the present invention is a motorized failsafe fly system winch which is compact and sufficiently versatile that it can easily be adapted for mounting along the theatre side walls or to a gridiron or to the ceiling.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described the preferred embodiments of the invention, and in which like reference numerals denote the same or similar components.

SUMMARY OF THE DRAWINGS

FIG. **1** is a side view of a fly system winch in accordance with the invention, shown in one configuration, with the base and drum assembly ready for mounting to a facility structure;

FIG. **2** is a longitudinal cross section of the fly system winch in the same configuration as shown on FIG. **1**;

FIG. **3** is a cross sectional view of the winch taken along line **3A**—**3A** of FIG. **1** and FIG. **2** illustrating one form of overspeed brake and sheave and sheave housing mounting on the carriage;

FIG. **4** is a cross sectional view of a winch system similar to that of FIG. **3** illustrating another form, in this case, a drum-type, of overspeed brake and another form of sheave and sheave housing mounting on the carriage;

FIG. **5** is a cross sectional view of a winch system similar to that of FIG. **3** illustrating the use of a disc-type overspeed brake;

FIG. **6** is a partial cross sectional view taken along the line **6A**—**6A** of FIG. **5** illustrating disc type overspeed brake components;

FIG. **7** is a side view of a fly system winch according to the invention, shown in another configuration, with the sheave carriage ready for mounting to the facility structure;

FIG. **8** is a side view of a fly system winch according to the invention, shown in still another configuration, with the sheave carriage ready for mounting to the facility structure. It differs from FIG. **7**, because the sheaves are mounted above the carriage;

FIG. **9** is a side view of a stage gridiron and fly set with a fly system winch according to the invention mounted on the gridiron and with loftblocks mounted over gridiron wells;

FIG. **10** is a side view of a stage gridiron and fly set with a fly system winch according to the invention mounted on the gridiron in between the loftblocks, with loftblocks mounted over the gridiron wells;

FIG. **11** is a side view of a stage gridiron and fly set with a fly system winch according to the invention mounted on the gridiron or on some other structure at stage right with loftblocks hung from the overhead steel;

FIG. **12** is a side view of a stage gridiron and fly set with fly system winches accoding to the invention mounted on the stagehouse wall, one above and one below the gridiron, with loftblocks and headblocks hung from the overhead steel;

FIG. **13** is a side view of a stage gridiron and fly set with a fly system winch according to the invention mounted below the stagehouse overhead steel at stage right, with loftblocks hung from the overhead steel;

FIG. **14** is a side view of the upper part of a stage house, without gridiron, with a fly system winch according to the invention and loftblocks hung from the overhead steel.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

As used in this application, a "flyset" typically is the combination of a batten, loft blocks (sheaves) and one or more support lines, for example, a wire cable or rope, attached to the batten and engaging a loft block. Typically, the number of loft blocks equals the number of support lines. A "batten" is the structural member typically supporting a scenic element. Typically the batten is a steel pipe, though other strip-type structural members can be substituted. When the scenery to be raised and lowered is, for example, a screen or backdrop extending laterally across the stage, the supporting batten typically has a length exceeding the width of the proscenium, i.e., the stage opening visible to the audience, and the batten would typically use 4–7 support lines spaced evenly across its top. As used herein, the terms "laterally: and "width" refer to the horizontal dimension or direction of the proscenium, and the term "vertically" refers to the vertical dimension or direction of the proscenium. The "stage ceiling" is the ceiling of the stage tower that is above and behind the open curtain and not visible to the audience. It typically extends, when the scenery is lifted straight up and removed from the view of the audience, to a distance above the top of the proscenium equal to or greater than the height of the scenery. The term "gridiron" refers to a rigid structural member typically composed of steel beams that forms an open grid structure extending parallel to and typically 6–7 feet below the stage ceiling out of view of the audience and which is capable of supporting various objects. "Wells" in the gridiron are larger openings through which support wires can be extended to battens or other structures beneath.

In a preferred embodiment, the invention is directed to a movable winch drum and carriage combination for raising and lowering objects such as theatre scenery and which incorporates functions for emergency braking, for moving the drum in synchronization with relation to a carriage and for driving of a limit switch. The winding and unwinding of the cables on or off the drum does not change the orientation of the cables relative to the facility or theatre. What this means is that the scenery typically moves vertically and not horizontally.

One form of fly system winch according to the invention is designated **1** in FIG. **1** and FIG. **2** (a longitudinal cross section of FIG. **1**). It includes a drum assembly **10** comprising a multi-line grooved cable drum **11**, rotatably-supported and directly driven at one end through a motorized gear reducer **37** and supported at the other end by an anti-friction bearing **39**. The anti-friction bearing **39** and the motorized gear reducer **37** are mounted on a base **30**. The cable drum II is supported from bearing **39** by an elongated hub, part of the cable drum **11** brake end cap **14**. The cable drum brake end cap **14** also forms the housing for parts of an overspeed brake **20**, which would engage in case of overspeed drum rotation, if caused by the motorized gear reducer **37** or a motor brake **38** failure. Under normal conditions, the load on the winch **1** is held by the motor or by the motor brake **38**, which is part of the motorized gear reducer **37**. All the above components, i.e., the drum, the drum supports and bearings, and the electrical driver (the motorized gear reducer), are mounted on base **30**.

A carriage **40**, with sheave housing **46** and plural sheaves **47**, is slideably mounted via slides **45** on a frame **41** of the base **30**, through linear bearings **35**A and **35**B (FIG. **3**) engaging the slides **45**. Plural cables **50** pass from the drum **11** over their respective vertically and horizontally offset cable-guiding sheaves **47**, over respective loftblocks **63** (as shown on FIG. **9**) to a pipe batten **64**, used for supporting the stage sets. In the configuration shown in FIG. **1** and FIG. **2**, the drum assembly **10** is mounted on base **30**, and base **30** is mounted to the facility structure (not shown in FIG. **1**) by means of mounting legs **34**. When the rotating drum **11** winds or unwinds the cables in the set of grooves, the cables **50** travel back or forth in the drum **11** grooves. Therefore, in order to provide straight cable runs between the horizontally-fixed drum assembly **11** and sheaves **47**, the carriage **40**, together with the sheaves **47**, has to travel laterally (parallel to the drum axis) in synchronization with and in the same direction as the cable back and forth travel in the drum **11** grooves. By a "straight cable run" is meant that the angular orientation between the drum and the cable-guiding sheaves is maintained, sometimes referred to as "zero fleet angle". So, for example, when the winch is mounted horizontally, the cables are maintained in a vertical orientation, and when the winch is mounted vertically, the cables are maintained in a horizontal orientation. If mounted at an angle, then the cable angular orientation is maintained.

A feature of this invention is that the cable drum assembly **10** is used for horizontally moving the carriage **40** together with its attached sheaves **47**, in relation to base **30**, which is fixed, in synchronization with the cable **50** back and forth travel in the drum **11** grooves. This is accomplished, in accordance with a preferred embodiment of the invention, by an ACME (or ball) screw **51**, connected non-rotatably to frame **41** of carriage **40** by a fixture **52**. A nut **53** is non-rotatably mounted to the drum assembly **10** brake end cap **14** elongated hub, which hub is hollow so that the screw **51** can pass, via the hollow hub, inside the drum **11**, which is also hollow, where the screw **51** is protected when the pipe batten with its attached scenery, hung from winch **1**, is in its up or storage position. The view in FIG. **1** with the screw **51** extending outside the drum occurs when the scenery is in its down position. Storing the screw **51** inside the hollow drum **11** is possible because the drum is not mounted on a separate shaft but the drum itself forms its own shaft. Another advantage of this construction is that it also reduces the overall length (its long dimension) of the winch **1**. Still further, another advantage is that the overspeed braking can be implemented with the larger diameter hub, which is less prone to fatigue and other failures than a smaller diameter shaft if the latter were used. The nut **53**, being secured to the hub, rotates together with the drum assembly and also with respect to the screw **51**. The pitch of the screw **51** thread is equal to the pitch of the drum **11** cable grooves. Therefore, the carriage **40** is moved in synchronization with the back or forth travel of the cables **50** in the drum **11** grooves. Straight cable paths are thus maintained between the drum **11** and cable-guiding sheaves **47**.

It will also be understood that, if the object to be raised is stored below the stage, its storage position, with the winch mounted above the stage, then it would be preferred to store the screw in the drum when the cable is unwound from the drum.

A sprocket **54** can also be readily mounted on the cable drum **11** brake end cap **14** for driving a limit switch **56** through a chain **55**. An encoder (not shown) can also be mounted into the limit switch **56** or in the motorized gear reducer. This construction can be used to limit the axial movement of the drum relative to the frame **41**, as well as used to establish the up and down limits of the travel, in-between limits of the travel, and to sense the speed.

Looking now at FIG. **2**, the grooved cable drum **11** can be constructed of one tubular member **12**, one drive end cap **13** and one brake end cap **14**, all welded together. One suitable material for the cable drum would be aluminum. The end caps **13** and **14** can be castings and would incorporate all the weld preps and interfacing details as part of their geometry. The drive end cap **13** supports one end of the drum **11** from the motorized gear reducer **37**. A brake **20** and end cap **14** support the other end of drum **11**, using the anti-friction bearing **39**, thus no separate shaft is required for supporting and rotating the drum **11**. Other materials than aluminum can be used for the drum **11**. Likewise one-piece construction of the drum **11** is possible while maintaining the functional features described herein.

The base **30** can comprise one horizontal member **33**, brake end vertical member **31** and drive end vertical member **32**. The brake end vertical member **31** and drive end vertical member can be aluminum castings, incorporating all mounting interfaces for motorized gear reducer **37**, anti-friction bearing **39**, overspeed brake **20** and outer ring **26**, and linear bearings **35**A and **35**B. An additional roller assembly (not shown) can be mounted on the base **30**, if required, for preventing the cables from jumping the drum **11** grooves. This roller assembly can be spring loaded and may incorporate sensors.

The vertical members **31** and **32** incorporate the geometry for all weld preparations necessary for welding them to the horizontal member **33**, which can be made of aluminum tubing. The mounting legs **34** can be fastened to the base **30** for mounting it to the facility structure. While aluminum construction is described herein, other materials and other means for constructing the base **30**, or connecting its components to each other, can be used.

As shown on FIG. **1** the carriage **40** frame **41** is L-shaped comprising a horizontal member **41**A and a vertical member **41**B. The sheave housing **46** is mounted at one side of the carriage **40**. The sheaves **47** are rotatably mounted into sheave housing **46** through bearings and shafts **48**. Spacers **49** can be used to tie the two sides of the sheave housing **46** together for increased stability and to prevent the cables **50** from jumping the sheave grooves. The carriage **40** is slideably connected to base **30** through slides **45**, which are rigidly fastened to the frame **41**. The slides **45** engage linear bearings **35**A and **35**B, mounted into the top portions of the base **30** vertical members **31** and **32**.

FIG. **3** is a cross sectional view **3**A—**3**A taken on FIG. **1** and FIG. **2** and showing one arrangement of the carriage **40**, including frame **41**, sheave housing **46**, slides **45** and sheaves **47**. In this configuration the sheaves and housing are mounted at right angles to frame **41**. If horizontal separation of cables **50** is required, the entire winch **1** can be mounted in tilted position. This is easily accomplished by simply rotating the entire winch in a manner similar to that shown in FIG. **4** CCW a small angle about the drum axis, which tilts the multiple sheaves **47** so that they are tilted as shown in FIG. **4** and thus their respective cables **50** horizontally separated when viewed in a plan view from the top of FIG. **3**.

FIG. **4** and FIG. **5** are cross sectional views similar to that of FIG. **3** but showing another possible arrangement of the carriage **40**, including frame **41**, sheave housing **46**, slides **45** and sheaves **47**, to horizontally separate the cables. In these configurations, sheaves **47** are mounted in a sloping position with respect to frame **41** and carriage **40**. This mounting permits horizontal separation of multiple cables **50** between the sheaves **47** and loftblocks (the horizontal separation in FIG. **11**, FIG. **13** and FIG. **14** is in a plane perpendicular to the plane of the drawings in those figures) so that the cables **50** would not rub against the sides of the loft blocks **63**, which is accomplished without tilting the base **30** and entire winch.

As shown on FIGS. **1** through **8**, the slides **45** are mounted on the carriage **40** horizontal member **41** A. A cylindrical linear bearing **35**A, which is self-aligning, engages a cylindrical portion of slide **45**. A flat linear bearing **35**B engages a flat portion of slide **45**. The entire carriage **40** or base **30** (depending on the winch **1** configuration) can be slideably supported, vertically and horizontally, by the two self-aligning linear bearings **35**A at opposite ends and vertically by the one flat linear bearing **35**B at one of the ends. This is possible, because the base **30** tubular horizontal member **33** provides torque transfer from overspeed brake **20** to base **30** drive end vertical member **32** at the end (left end in FIG. **1**) where the flat linear bearing **35**B can be installed, because this is where the normal drum assembly **10** driving torque is applied by the motorized gear reducer **37**. Since the flat linear bearing **35**B is free to move horizontally in FIG. **3**, in a direction perpendicular to its travel (in and out of the plane of the drawing of FIG. **3**), its use, together with the two self-aligning cylindrical linear bearings **35**A, eliminates the need for precise alignment of slides **45**. This self-alignment feature derives from the resultant 3-point support of the carriage, which causes the carriage to “float” horizontally and also have a small amount of vertical movement. This is an important feature of the invention. If a second flat linear bearing **35**B is used at the base overspeed brake end member **31**, its purpose would be secondary safety and it can be fitted over slide **45** with loose tolerances. Stated another way, the cylindrical linear bearing **35**A supports the carriage or drum in all directions perpendicular to the drum axis (but not parallel to the drum axis), whereas the flat linear bearing **35**B supports the carriage or drum in only one direction perpendicular to the drum axis. So, for example, when the drum is arranged horizontally, the support is in the vertical direction, and when the drum is arranged vertically, the support is in the horizontal direction.

As shown on FIGS. **1**–**3**, FIG. **7**, and FIG. **8**, as a further feature of the invention, the drum assembly **10** incorporates an overspeed brake **20**, with pawls **21**, linkages **22**, and a release detent **23** installed into the drum **11** brake end cap **14**. This eliminates the need for connecting a separate overspeed brake to the drum through shafting and couplings and reduces the size of the assembly and the number of component parts. Incorporating several of the components of the overspeed brake **20** into the drum assembly, which is made possible because of the absence of a separate supporting solid drum shaft, also has the advantage of improving safety. In case of accidental overspeed, the centrifugal force applied on pawls **21** would release the detent **23** and the pawls **21** would engage the notches **21**A in a pawl ring **24**, thus applying the torque from the rotating drum **11** to the pawl ring **24**. The torque is resisted by friction between the pawl ring **24** and a brake lining **25**, part of an outer ring **26**. The outer ring **26** is connected to and supported by the base **30**.

This overspeed brake **20** has features which permit testing the braking torque, verifying the pawls **21** release forces, and adjusting the release detent **23** pressures without removing the brake **20** components or drum **11** from the base **30**. Looking at FIG. **2** and FIG. **3**, the extended hub of the drum **11** brake end cap **14** has a built in torque test key **15**. The pawls **21** have threaded holes **27** for mounting a manual actuation lever. By screwing the actuation lever (not shown) into the mounting hole **27**, the pawls **21** can be manually engaged into the pawl ring **24** notches. The motor brake **38** would then be released. A wrench (not shown) can be installed around the extended hub of the drum brake end cap **14** and its key **15**. By measuring the force on the wrench, the slipping torque between the brake lining **25** and pawl ring **24** can be determined. The torque can be adjusted by tightening or loosening the torque adjustment screws **28** on the brake outer ring **26**. After adjusting the torque, the pawls **21** would be disengaged by use of the manual actuation lever and the lever would then be removed.

Similarly, a lever, screwed into its mounting hole **27** in pawl **21**, can be used, together with a force measuring device, for measuring the force required to release the pawls, which force directly relates to the drum **11** rotational speed. The force release can be adjusted by increasing or decreasing the pressure on release detent **23**.

While a particular drum type brake is shown on FIG. **3**, other drum or disc type brakes can be incorporated into the drum **11** as part of the drum brake end cap **14**.

Another drum type overspeed brake is shown in FIG. **4**. In this arrangement a single pawl **101** is pivotally mounted on base **30**. The pawl **101** is connected to a solenoid **103**, through a linkage bar **104**. Brake shoes **106** with brake lining **107** are pivotally mounted to the drum **11** brake end cap **14** through pins or shoulder screws **108**. The brake shoes **106** can be forced against a pawl ring **102** by a wedge shaped block **109** fastened to the drum brake end cap **14**. By tightening screws **110**, the sloping ends of the block **109** are forced against the sloping ends of the brake shoes **106** and the brake shoes are forced against the inside face of the pawl ring **109**. During a lifting or lowering operation, the solenoid **103** is energized and the pawl **101** is disengaged from notches **101**A. The pawl ring **102**, brake shoes **106**, and block **109** all mounted to the drum **11** brake end cap **14** and are free to rotate with the drum. When the drum rotational overspeed is sensed electronically, electric power is cut from the solenoid **103**. The spring **105** forces the pawl **101** against the outer surface of the pawl ring **102**, and, when the pawl ring **102** rotates with the drum **11**, the pawl **101** will slide, under the force applied by spring **105**, into a notch **101**A of the pawl ring **102** and stop the rotation of pawl ring **102**. The friction between the pawl ring **102** and the brake lining **107** will decelerate and stop the cable drum **11**. The amount of friction generated can be adjusted by tightening or loosening the screws **110** forcing the wedge-shaped block **109** against the brake shoes **106**. Cams, stiff disc springs or other means can be used instead of the wedge shaped block **109** for forcing the shoe **106** against the pawl ring **102**.

The advantages of the type of overspeed brake described in connection with FIG. **4** is that electronic overspeed sensing is accurate and when the solenoid **103** deenergizes, the pawl **104** is always forced against the pawl ring **102** by spring **105**. Therefore, when the winch is stopped supporting a load and if the motorized gear reducer **37** or motor brake **38** fails, the drum **111** can only rotate until the pawl **101** engages under spring **105** pressure the notch **101**A in the pawl ring **102** for initiating the stopping sequence.

A disc type overspeed brake modification is shown in FIG. **5** and FIG. **6**, which is a partial cross sectional view taken on FIG. **5**, along line **6**A—**6**A, limited to showing the drum brake end cap **14**, components of overspeed brake **20** and bearing **39**. A bushing **209** is pressed on the drum brake end cap **14** hub portion. Friction discs **208** (made of brake lining material) and pawl disc **202** are rotatably mounted, with respect to the drum brake end cap **14**, over the bushing **209**. A pressure plate **206** is slideably mounted on the drum brake end cap **14** hub portion. The rotation of pressure plate **14** can be prevented by keys, splines or by flattened sides of the drum brake end cap **14** hub portion, as shown in FIG. **5**. The pawl disc **202**, the friction discs **208**, and the pressure plate **206** are forced against each other and against the drum brake end cap **14** by disc spring **207**. A disc spring retainer **210** is sldeably mounted on the hub portion of the drum brake end cap **14**. Force is applied to all the above components by nut **211** threaded on the drum brake and cap **14** hub portion. The force and the related friction between the drum brake end cap **14**, pawl disc **202**, pressure plate **206** and friction discs **208** can be adjusted by tightening or loosening the nut **211**. Screws **212** can be installed for additional pressure adjustment. During normal raising or lowering, all the above described parts rotate with drum **11**. The pawl **201**, pivotably mounted on base **30**, is held at disengaged position through linkage **204** by solenoid **203**, which is also mounted on base **30**. When the drum rotational overspeed is sensed electronically, electric power is cut from the solenoid **203**. The spring **205** forces the pawl **201** against the pawl disc **202** outer rim. When the pawl disc **202** rotates with the drum **11**, pawl **201** will slide, under the force applied by spring **205**, into the notch **201**A of pawl disc **202** and stop the rotation of pawl disc **202**. The friction between the pawl disc **202** and friction discs **208** shall decelerate and stop the rotation of cable drum **11**.

The advantages of the disc type overspeed brake shown in FIG. **5** and FIG. **6** are identical to what is described for the drum type brake shown in FIG. **4**.

FIG. **7** is a side view of a fly system winch **1** in accordance with the invention in another configuration. In the previous embodiments, the base **30** is fixed, as is the drum horizontally. The carriage **40** and sheave assembly **46** is moved laterally in synchronization with the back and forth travel of the cables **50** in the rotating drum **11** grooves with respect to the base member **30**. In this FIG. **7** configuration, the carriage **40** is fastened via legs **34** to the facility structure (not shown) and the entire drum assembly **10**, including its base **30** and motorized gear reducer **37**, travels horizontally relative to the carriage frame **41**, which is fixed to the facility structure, when winding or unwinding of the cables **50**. All the parts in this configuration are identical to the parts used for the winch configuration shown in FIG. **1** and FIG. **2**, except that the carriage frame **41** is modified. An additional vertical member **41**C is added to support the carriage **40**. This configuration has a functional advantage, because the horizontal forces from the cables **50** are not applied to the screw **51** as in FIG. **1**. In the case of FIG. **7**, the only forces applied on the screw **51** are the friction forces between the linear bearings **35**A, **35**B and slides **45**. Furthermore, since the carriage **40** together with sheaves **47** does not move, the cables **50** travel rates and travel distances are not affected by horizontal movement of the carriage **40** of which there is none. This feature permits at least one sheave **47**A or more sheaves to be mounted on carriage **46** at the other sides of the vertical cable **50** runs between the drum **11** and sheaves **47**, so that these cables lead out from the winch **1** in the opposite direction (to the left as shown on FIGS. **10** and **14**). This permits winch **1** to be mounted in between gridiron slots instead of at one side, and eliminates the need for extending the gridiron and stage house to the side stage walls. It also contains all the horizontal rigging loads, applied by nearly horizontal cable runs above the gridiron, within the gridiron structure.

FIG. **8** is another modification of the winch **1** configuration, similar to that shown in FIG. **7**, with the fixed carriage **40** and movable drum assembly **10**, except that the sheave housing **46** and sheaves **47** are mounted to the top side of frame **41** horizontal member **41**B. With the exception of the modified location of sheave housing **46** and base **30** with respect to carriage **40**, the configuration shown in FIG. **8** maintains all the features of the winch configuration shown in FIG. **7**. The FIG. **8** configuration also permits angular lead out of cables, as shown in FIG. **11** and FIG. **12**, without differential cable velocities.

Based on the features described above, and because the base **30** horizontal member **33** is narrower than drum **11**, the fly system winch **1**, as shown in FIG. **7** and FIG. **8** can be configured as a spotline winch, using a shorter drum assembly **10** with a single cable leading straight down from the drum **11** or down over an additional sheave to the object to be supported. The single cable leading down would not move horizontally during raising and lowering of the cable-supported object because the drum assembly **10** together with its base **30** travels horizontally in synchronization with the cable winding or unwinding. In this case, the sheave housing **46** and sheaves **47** would not be used on the carriage **40** frame **41**. This single configuration would be usable when, for example, the winch is mounted on the gridiron, and the single cable goes straight down (no sheaves needed) through a gridiron well to raise or lower any single object while still providing the screw protection inside the drum. No tooling change would be required for fabrication of components for this modified configuration. Similarly, the cable **50** travel distances can be increased or cables added (or removed) by simply lengthening or shortening the drum **11** tubing **12**, together with the base **30** and frame **41** horizontal members **33** and **43** without change of tooling for fabrication of components.

Other fly system winch **1** modifications and derivations are also possible based on the principles outlined above.

The features described herein permit production of several different configurations of the fly system winch **1** with mostly identical parts and with none or only minor tooling changes for weldments. This is especially beneficial for retrofit projects where the fly system winch **1** interfacing conditions vary for many facility structures.

FIG. **9** shows one installation where the fly system winch **1**, shown either in FIG. **1** or in FIG. **8**, is mounted on the gridiron **60** at stage right. It will be appreciated from the foregoing discussion that it can just as easily be mounted if desired at stage left, or another fly system winch also mounted at stage left. This is also true for the arrangements shown in FIGS. **10**, **11**, **13** and **14**. Cables **50** pass from winch **1** sheaves **47** over loftblocks **63** mounted over the wells **61** of stage gridiron **60** to the pipe batten **64** below from which the scenery is suspended.

FIG. **10** shows an installation where the fly system winch **1**, shown in FIG. **7** or FIG. **8**, via its carriage, is mounted on the gridiron **60**, in between gridiron wells **61** and loftblocks **63**. The cables **50** pass over the loftblocks **63** mounted on gridiron wells **61** and then down to the pipe batten **64**. Note that the cables **50** can pass in both lateral directions from the intermediate mounting of the winch **1** between the loftblocks **63**. This arrangement is especially practical for installations where there is no space for mounting the winches **1** at stage right, or right outside the area bordered by the grid wells **61**. The winch configuration shown on FIG. **1** cannot be placed between the loftblocks **63**, because the horizontally moving carriage **40** would cause undesired differential cable travel.

FIG. **11** shows an installation where the fly system winch **1**, shown in FIG. **8**, is mounted at stage right for use with overhead loftblocks **63**. In this case the loftblocks **63** are hung from overhead loftblock beams **62**. Cables **50** pass over a multi-line loftblock **65**, and one cable drops down from multi-line loftblock **65**. The other cables pass over loftblocks **63** and drop down to the pipe batten **64** through the gridiron wells **61**. The winch configuration shown in FIG. **1** cannot be used in this case, because diagonal cable leads from the movable carriage **40** would cause undesired differential cable travel.

FIG. **12** shows another installation where fly system winches **1**, shown in FIG. **7** and FIG. **8**, are mounted on the stagehouse side walls and are used with overhead loftblocks **63**. A similar mounting arrangement of winches **1** can be used with grid mounted loftblocks as shown in FIG. **9**.

FIG. **13** shows an installation where fly system winches **1** shown in FIG. **1**, FIG. **7** or FIG. **8** are mounted to the stagehouse overhead steel for use with underhung loftblocks **63** mounted to the underside of overhead loftblock beams **62**. The same mounting arrangement of winch **1** can be used for stages where no gridiron **60** exists. In this case, a multi-line loftblock **65** can be used for horizontal spacing of cables required to clear the sides of loftblocks **63**. As an alternative, winch **1** can be tilted or the sheave housing can be tilted as shown in FIG. **4**.

FIG. **14** shows an installation where the fly system winch **1** shown in FIG. **7** is mounted to the underside of the stagehouse ceiling beams for installations where a gridiron **60** is not used. In this case, a multi-line loftblock **65** can be used for horizontal spacing of the cables required to clear the sides of loftblocks **63**. As an alternative, winch **1** can be tilted or the sheave housing can be tilted as shown in FIG. **4**. Note that the cables **50** can pass in both lateral directions from the intermediate mounting of the winch **1** between the loftblocks **63**, **65**.

Other installation options are possible within the principles of the invention.

Among the benefits of the invention are that the fly system winch is comprised of multifunctional components. This permits reduction of the number of winch component parts, normally used for other fly system winches, without reducing the winch operational functionality in a compact self-contained assembly. As one example, which is not to be considered limiting, for a medium sized theatre, the entire drum assembly and supporting base for one flyset can be reduced to approximately 5 feet in length, which is less than one-half the typical lateral spacing between loftblocks, and will be capable of supplying 4–6 cables approximately 8–12 feet (center line to center line) apart. In a typical theatre installation, by placing the fly system winches on opposite sides of the stage, or in multiple rows on the same side of the stage, the pipe batten front-to-back spacings can be as little as 5½ inches. The fly system winch construction of the invention also utilizes extrusions and castings, made of aluminum or other suitable materials, permitting quality fly system winch construction without excessive tooling requirements and thus at lower cost. Another important advantage is the adaptability of the winch of the invention for a variety of facility interfacing conditions as shown, by use of standardized mounting elements, without the need to change the basic winch components or assemblies. This invention permits the installation of the winches even between the loftblocks, which is not believed possible with other horizontal single-drum type winches. Such an installation option is especially useful in theaters where the off stage gridiron area is limited. In addition, the versatile winch of the invention can be installed in a horizontal position, with its mounting legs below or above the drum, at or adjacent or above or below the gridiron level, or vertically at either side of the stage. Also, it can be installed so that its cable runs are horizontal, vertical or angled. In addition, it can be installed such that the support lines extend laterally in both directions from the winch. This is not believed possible with other known single-drum winch systems. Also, when the drum provides plural support lines for the batten, as here, breakage of one of the lines will not cause the scenery to fall as adequate support will be provided by the other intact lines.

It will also be appreciated that the invention is not limited to raising and lowering scenic elements in a theatre, but can also be used in any facility with a need for raising and lowering any object, such as, for example, objects in a theme park.

While the invention has been described in connection with preferred embodiments, it will be understood that modifications thereof within the principles outlined above will be evident to those skilled in the art and thus the invention is not limited to the preferred embodiments but is intended to encompass such modifications.

What is claimed is:

1. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object with respect to a stage,

a) said facility having plural spaced loftblocks mounted above the stage,

b) said motorized fly system comprising:

i) a support carriage and plural cable-guiding devices mounted on said carriage,

ii) a base member having first and second end portions,

iii) an elongated hollow drum having grooves and having a longitudinal axis and rotatably mounted on the base member and plural cables for simultaneously winding and unwinding the cables on or off the drum grooves when the drum is rotated, said cables passing from the outside of the drum over the cable-guiding devices to the spaced loftblocks, respectively, for supporting an object such that rotation of the drum causes the object to move down and up with respect to the stage,

iv) first means for slideably mounting the base member to the carriage,

v) said drum having at a first end a hollow hub rotatably journalled at the first end of the base member,

vi) second means for rotating the drum relative to the carriage such that the base member with its drum and the carriage can move with respect to each other in synchronism with the rotation of the drum to control the cable runs to their respective cable-guiding devices,

vii) a screw axially aligned with the hollow hub and the hollow drum and connected to the drum and non-rotatably connected to the carriage such that the screw extends outside of the hollow drum when the object is in a down or up position and moves through the hollow hub into the hollow drum when the drum is rotated to move the object to its up or down position, respectively.

2. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object as set forth in claim **1**, further comprising a gridiron, the loftblocks are mounted along the gridiron and the motorized fly system is mounted on and at one side of the gridiron.

3. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object as set forth in claim **1**, further comprising a gridiron, the loftblocks being mounted along the gridiron and the carriage of the motorized fly system being mounted on the gridiron between the loftblocks, some of the cables passing toward one side of the gridiron, others of the cables passing toward the opposite side of the gridiron.

4. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object as set forth in claim **3**, further comprising a gridiron, the loftblocks being mounted above the gridiron and the carriage of the motorized fly system being mounted on and at one side of the gridiron, the cables angling upward from the cable-guiding means to the loftblocks.

5. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object as set forth in claim **1**, further comprising a gridiron, the loftblocks being mounted above the gridiron and the motorized fly system being mounted on the facility spaced from the gridiron.

6. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object as set forth in claim **1**, wherein the facility has a ceiling above the stage, the loftblocks are mounted at the stage ceiling and the motorized fly system is mounted on the facility ceiling spaced from the gridiron.

7. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object as set forth in claim **1**, wherein the facility has a ceiling, the loftblocks are mounted along the ceiling and the carriage of the motorized fly system is mounted on the ceiling between the loftblocks, some of the cables passing toward one side of the ceiling, others of the cables passing toward the opposite side of the ceiling.

8. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object as set forth in claim **1**, further comprising a gridiron mounted over the stage, the overall length of the motorized fly system winch, drum and carriage combination being much smaller than the width of the gridiron.

9. A facility and a motorized fly system winch, drum and carriage combination secured to the facility for raising and lowering an object as set forth in claim **8**, wherein the overall length of the motorized fly system winch, drum and carriage combination is smaller than about one-half the spacing between the loftblocks.

10. A motorized fly system winch, drum and carriage combination for raising and lowering objects, comprising:

a) a support carriage and at least one cable-guiding device mounted on said carriage,

b) a base member having first and second end portions,

c) an elongated drum having grooves rotatably mounted on the base member and at least one cable for winding and unwinding the cable on or off the drum grooves when the drum is rotated, said cable passing from the drum over the cable-guiding device for supporting a object such that rotation of the drum causes the object to move up and down,

d) first means for slideably mounting the base member to the carriage such that the base member with its drum and the carriage can move with respect to each other in synchronism with the rotation of the drum to control the cable run to the cable-guiding device,

e) said first means for slideably mounting comprising second means at the first end portion of the base member for supporting the base member in all directions perpendicular to the drum axis, and third means at the second end portion of the base member for supporting the base member in one direction perpendicular to the drum axis for self-alignment of the base member and the carriage.

11. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **10**, wherein the second means and third means combine to provide a 3-point slideable linear bearing support of the base member to the carriage.

12. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **10**, wherein the second means provides two points of linear bearing support of the base member to the carriage one at the first and the other at the second end portions of the drum and the third means provides one point of linear bearing support of the base member to the carriage at the second end portion of the drum.

13. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **12**, wherein the second means comprises a first cylindrical linear bearing at the first end portion of the drum and a second cylindrical linear bearing at the second end portion of the drum and both cylindrical linear bearings being at the same side of the base member, and the third means provides a flat linear bearing at the second end portion of the drum at the side of the base member opposite to that of the first and second cylindrical linear bearings.

14. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **13**, further comprising driving means at the second end portion of the base member and directly connected to the drum for rotating the drum and overspeed braking means at the first end portion of the base member.

15. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **10**, wherein the drum contains plural cables and the carriage comprises plural spaced cable-guiding means each for guiding one of the cables to the object.

16. A motorized fly system winch, drum and carriage combination for raising and lowering objects, comprising:

a) a support carriage and at least one cable-guiding device mounted on said carriage,

b) a base member having first and second end portions,

c) an elongated drum rotatably mounted on the base member and at least one cable for winding and unwinding the cable on or off the drum when the drum is rotated, said cable passing from the drum over the cable-guiding device for supporting an object such that rotation of the drum causes the object to move up and down,

d) first means for slideably mounting the base member to the carriage such that the base member with its drum and the carriage can move with respect to each other in synchronism with the rotation of the drum to control the cable run to the object,

e) said drum having at a first end a hollow hub rotatably journalled at the first end portion of the base member,

f) an overspeed brake located in part within the hollow hub leaving a vacant center space and operative to brake the drum with respect to the base member in response to its rotation velocity exceeding a predetermined value.

17. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **16**, further comprising means for testing the performance of the overspeed brake incorporated in part within the hollow hub, said means for testing allowing testing of the overspeed brake's performance without removing same from the hollow hub.

18. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **16**, wherein the overspeed brake comprises pawls on the hub and rotatable with the drum and a torque-resisting ring connected to the base member and surrounding the pawls, said pawls being operative in response to centrigugal forces to engage the torque-resisting ring when the drum's velocity exceeds a predetermined value.

19. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **16**, wherein the overspeed brake comprises at least one pawl on the base member and a torque-resisting ring rotatable with the drum and radially spaced from the pawl, said pawl being operative in response to an electrical signal generated when the drum's velocity exceeds a predetermined value to engage the torque-resisting ring.

20. A motorized fly system winch, drum and carriage combination for raising and lowering objects as set forth in claim **16**, wherein the overspeed brake comprises at least one pawl on the base member and a torque-resisting disc in frictional engagement with the drum and rotatable with the drum and radially spaced from the pawl, said pawl being operative in response to an electrical signal generated when the drum's velocity exceeds a predetermined value to engage the torque-resisting disc stopping its rotation and forcing the drum to stop rotating.

21. A motorized fly system winch, drum and carriage combination for raising and lowering scenery, comprising:

a) a support carriage and plural cable-guiding devices mounted on said carriage,

b) a base member having first and second end portions,

c) an elongated hollow drum having cable grooves and having a longitudinal axis and rotatably mounted on the base member and plural cables for simultaneously winding and unwinding the cables on or off the drum grooves when the drum is rotated, said cables passing from the outside of the drum over, respectively, the cable-guiding devices for supporting scenery such that rotation of the drum causes the scenery to move up and down,

d) first means for slideably mounting the base member to the carriage,

e) said drum having at a first end a hollow hub rotatably journalled at the first end portion of the base member,

f) second means for rotating the drum relative to the base member such that the base member with its drum and the carriage can move with respect to each other in synchronism with the rotation of the drum to control the cable runs to the plural cable-guiding devices, respectively,

g) said second means comprising an elongated screw having a first end non-rotatably mounted to the carriage and a second end threadingly engaging a like threaded member non-rotatably connected to the drum and axially aligned with the hollow hub and the hollow drum, said screw extending mainly outside of the hollow drum when the cables are wound up on or unwound from the drum and the scenery is in its respective up or down position,

h) said hollow hub and hollow drum being sized such that the screw can move into the hollow hub to allow the hollow drum to receive the screw as the cables unwind from or wind up on the drum as the scenery moves to its respective down or up position.

22. A motorized fly system winch, drum and carriage combination for raising and lowering scenery as set forth in claim **21**, wherein the scenery has a storage position and the screw is positioned inside the hollow drum when the scenery is in its storage position.

23. A motorized fly system winch, drum and carriage combination for raising and lowering scenery as set forth in claim **21**, wherein the drum surface is grooved to receive the cables, the drum grooves have a certain pitch, and the pitch of the screw thread is the same as that of the drum grooves.

24. A motorized fly system winch, drum and carriage combination for raising and lowering scenery inside a theatre as set forth in claim **21**, further comprising third means for mounting the fly system winch, drum and carriage combination to the theatre.

25. A motorized fly system winch, drum and carriage combination for raising and lowering scenery as set forth in claim **24**, wherein the third means are secured to the base member.

26. A motorized fly system winch, drum and carriage combination for raising and lowering scenery as set forth in claim **24**, wherein the third means are secured to the carriage.

27. A motorized fly system winch, drum and carriage combination for raising and lowering an object, comprising:

a) a carriage,

b) a base member having first and second end portions,

c) an elongated hollow drum having cable grooves and having a longitudinal axis and rotatably mounted on the base member and a cable for simultaneously winding and unwinding the cable on or off the drum grooves when the drum is rotated, said cable passing from the outside of the drum directly or via a sheave to the object such that rotation of the drum causes the object to move up and down,

d) first means for slideably mounting the base member to the carriage,

e) said drum having at a first end a hollow hub rotatably journalled at the first end portion of the base member,

f) second means for rotating the drum relative to the base member such that the base member with its drum and the carriage can move with respect to each other in synchronism with the rotation of the drum to control the cable run to the object,

g) said second means comprising an elongated screw having a first end non-rotatably mounted to the carriage and a second end connected to the drum and axially aligned with the hollow hub and the hollow drum, said screw extending mainly outside of the hollow drum when the cable is wound up on or unwound from the drum and the object is in its respective up or down position,

h) said hollow hub and hollow drum being sized such that the screw can move into the hollow hub to allow the hollow drum to receive the screw as the cable unwinds from or winds up on the drum as the object moves to its respective down or up position.

28. A motorized fly system winch, drum and carriage combination for raising and lowering an object as claimed in claim **27**, further comprising a facility, said carriage being mounted to the facility.

29. A motorized fly system winch, drum and carriage combination for raising and lowering an object as claimed in claim **27**, further comprising:

i) third means for slideably mounting the base member to the carriage,

j) third means for slideably mounting comprising fourth means at the first end portion of the base member for supporting the base member in all directions perpendicular to the drum axis, and fifth means at the second end portion of the base member for supporting the base member in one direction perpendicular to the drum axis for self-alignment of the base member and the carriage.

30. A motorized fly system winch, drum and carriage combination for raising and lowering an object as claimed in claim **27**, further comprising:

i) an overspeed brake located in part within the hollow hub leaving a vacant center space and operative to brake the drum with respect to the base member in response to its rotation velocity exceeding a predetermined value.

31. A motorized fly system winch, drum and carriage combination for raising and lowering objects, comprising:

a) a support carriage and at least one cable-guiding device mounted on said carriage,

b) a base member having first and second end portions,

c) an elongated drum rotatably mounted on the base member and at least one cable for winding and unwinding the cable on or off the drum when the drum is rotated, said cable passing from the drum over the cable-guiding device for supporting an object such that rotation of the drum causes the object to move up and down,

d) first means for rotating the drum relative to the carriage, said first means also functioning as a primary holding brake for the drum and its object,

e) second means for slideably mounting the base member to the carriage such that the base member with its drum and the carriage can move with respect to each other in synchronism with the rotation of the drum to control the cable run to the object,

f) said drum having at a first end a hollow hub rotatably journalled at the first end portion of the base member,

g) an overspeed secondary holding brake mounted on the drum and located in part within the hollow hub leaving a vacant center space and operative to brake the drum with respect to the base member in response to its rotation velocity exceeding an unsafe value.

32. A motorized fly system winch, drum and carriage combination for raising and lowering objects as claimed in claim **31**, wherein the secondary holding brake comprises pawls and frictional surfaces to effect the braking action.

33. A motorized fly system winch, drum and carriage combination for raising and lowering objects as claimed in claim **32**, wherein means are provided for activating the pawls to effect a braking action in response to centrifugal force or an electrical impulse generated by a rotation velocity sensor.

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